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Island about three hours after the eclipse occurred, the plan being to develop the photographs in the dark-room on his vessel. We hope that his photographs have been found to be excellent.

W. W. CAMPBELL.

GOLDEN GATE, January 25, 1908.

SOME TESTS OF THE VERTICAL CŒLOSTAT OR "TOWER" TELESCOPE OF THE MT. WILSON SOLAR OBSERVATORY.

The vertical cœlostat telescope described in *Contributions from the Solar Observatory*, No. 14, was erected on Mt. Wilson last summer, and has been in regular use since October. A 17-inch cœlostat, with mirror 12 inches thick, is mounted at the summit of a steel tower 65 feet in height. From the cœlostat the sunlight is reflected to a second mirror of elliptical form, which sends it vertically downward to a 12-inch visual objective of 60 feet focal length. The solar image is formed in a house at the base of the tower, where it is studied with a spectrograph of 30 feet focal length, standing in an underground chamber 8½ feet in diameter and 30 feet deep. A spectroheliograph, also of 30 feet focal length, is being constructed for use with this telescope, but at present a simple attachment to the spectrograph adapts it for the monochromatic photography of the Sun.

The 5-foot spectroheliograph, when used with the Snow telescope, yields excellent photographs of the calcium, hydrogen, and iron flocculi. For narrower lines, however, higher dispersion is required, which involves longer exposures. With the Snow telescope these cannot be given, on account of the change of figure of the mirrors in sunlight. There is not only a marked lengthening of the focus, but also a decided effect of astigmatism, due to the distortion of the two plane mirrors. The mirrors of the vertical cœlostat telescope (commonly known as the "tower" telescope) were made very thick in the hope of reducing this distortion.

This plan has succeeded admirably, though there is reason to believe that even better results would have been obtained if somewhat thinner glass disks had been used for the mirrors. The change of focus is so slow that an exposure of half an hour or more can be given with the spectroheliograph. Moreover, no effects of astigmatism have been noticed until after the telescope has been in continuous use for several hours.

It is a curious fact that with this telescope the focal length *shortens,* while with the Snow telescope it lengthens, on exposure to the Sun. This appears to be due to the fact that the broad edges of the very thick mirrors, when heated by the air, expand and render the front and rear surfaces of the mirrors concave.

In the morning, when the temperature of the air is rising, the slow change of focus continues, even when the mirrors are shielded from the Sun. In the afternoon, when the temperature is falling, continued exposure to the Sun fails to prevent a return of the figure to normal. These facts seem to favor the explanation suggested above.

It was hoped that the great elevation of the cœlostat above the heated ground, and the use of a vertical, rather than a horizontal beam, would prove advantageous. This expectation has also been realized. The definition always appears to be from one to two points (on a scale of ten) better than with the Snow telescope. In making the comparative tests care was taken to keep the mirrors of the Snow telescope covered until the simultaneous observations were made, and to cut down the aperture to twelve inches.

Spot spectra photographed with the 30-foot Littrow spectrograph by Mr. ADAMS and myself are much superior to those secured with the 18-foot Littrow spectrograph of the Snow telescope. As they are made in the third and fourth orders of a 4-inch grating (the one formerly used with the 18-foot spectrograph, and the only one available for the higher orders), the scale is great enough to permit measurements of high precision to be made. Some of the photographs already obtained are suitable for the definitive map of the sun-spot spectrum, on the scale of Rowland, which will be issued as soon as a sufficient range of the spectrum has been covered.

Excellent photographs of the spectra of the limb and center of the Sun, and good preliminary results with the spectroheliograph, have also been obtained. The tower telescope appears to be a decided success, and will prove a most valuable supplement to the Snow telescope, which still possesses special advantages for certain classes of work.

GEORGE E. HALE.